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perform a plurality of search types using a single hardware set.

Still another object of the present invention is to provide a bit string check method and device wherein an
5 increase in the length of a bit string (key) to be searched can be coped with by adding a unit or repeating a series of processes without the need for an algorithmic change of hardware.

10 **DISCLOSURE OF THE INVENTION**

In a bit string check method of the present invention, there is employed a method including the process of dividing a bit string to be searched into a plurality of partial-object bit strings (partial bit string to be searched), and
15 comparing at respective stages with a plurality of bit patterns registered in advance. A current stage which is one of the check stages included in the multiple stages comprises: an all-check step of selecting a partial-object bit string of the current stage from the bit string to be
20 searched and comparing it with all possible values of a partial-object bit string of the current stage; and a pattern loading step of loading a pattern table of the current stage from a memory before, after or in parallel with the all-check step, the pattern table being for
25 indicating a partial registration bit pattern of each of the

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plurality of registration bit patterns, the pattern table being determined by check-continuation information received from a stage preceding the current stage. The pattern table of the current stage represents partial registration bit
5 patterns to be compared with the partial-object bit string of the current stage.

The current stage further comprises a judgment step of obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the
10 current stage which matches the partial-object bit string of the current stage in accordance with the result of the all-check step and the pattern table of the current stage; and an outputting step of outputting check-continuation information including the address of a pattern table of the
15 stage subsequent to the current stage from an address table corresponding to the pattern table of the current stage in accordance with the check result.

The address table represents the address of the pattern tables of the next stage subsequent to respective
20 partial registration bit patterns on the pattern table of the current stage. Thus, from the address table, it is possible to output check-continuation information including the address of the pattern table of the next stage indicating a partial registration bit pattern to be checked
25 in the next stage, subsequent to the matched partial

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registration bit pattern in the current stage.

As a check device for realizing the above check method,
in the present invention, there is provided a check device
for executing at lease one stage included in multiple stages
5 so as to check against a plurality of bit patterns
registered in advance at the multiple stages with dividing a
bit string to be searched into a plurality of partial-object
bit strings. The check device comprises all-check means for
selecting a partial-object bit string of the current stage
10 from the bit string to be searched and for comparing the
partial-object bit string of the current stage with all
possible values of a partial-object bit string of the
current stage; pattern loading means for loading a pattern
table of the current stage from a memory, the pattern table
15 being for indicating a partial registration bit pattern of
each of the plurality of registration bit patterns, the
pattern table being determined by check-continuation
information received from a stage preceding the current
stage; judgment means for obtaining a check result
20 indicating at least a presence or absence of the partial
registration bit pattern of the current stage which matches
the partial-object bit string of the current stage in
accordance with the result of the all-check means and the
pattern table of the current stage; and outputting means for
25 outputting check-continuation information including the

partial-object bit string. On the other hand, the minimum partial registration bit pattern closest to the value of the partial-object bit string means a partial registration bit pattern that has the smallest value of partial registration bit patterns larger than the partial-object bit string. In accordance with the selection of the address of the pattern table subsequent to the maximum partial registration bit pattern, a right-inclined scope search to be described later is enabled. Further, in accordance with the selection of the address of the pattern table subsequent to the minimum partial registration bit pattern, a left-inclined scope search to be described later is enabled. Hence, in the searching of the right-inclined type, the maximum side to be described later is selected, and in the searching of the left-inclined type, the minimum side to be described later is selected.

Further, in the check method and check device of the present invention, at one stage (current stage) of the multiple check stages, comparison is made with all the possible values of a partial-object bit string by the all-check step and all-check means. A complete match or a scope match is lead from the check result and the pattern table of the current stage indicating the partial registration bit pattern (hereinafter, also referred to as an 'entry') of the current stage, to be object compared with the partial

registration bit pattern of the current stage.

The pattern table does not need to be a bit string of a partial entry, but, from the viewpoint of data amount, is preferably data representing the value of the partial entry
5 directly or using a bit pattern or a flag in a form corresponding to the partial entry. The present invention comprises the all-check step or all-check means for comparing all the possible values of a partial-object bit string. Hence, when executing the all-check, within the
10 values to be compared, the pattern table can be given as mask data consisting of a bit flag indicating a validness or invalidness of the partial registration bit pattern. That is, in the all-check, since the range of the possible values of a partial-object bit string is fixed in advance, it is
15 possible to store the pattern table in the memory as such mask data and to load it from the memory. Hence, in the pattern loading step and means, the mask data is loaded from a memory.

Further, in this check method and device, as a
20 comparison is made between all the possible values of a partial-object bit string, an amount or area capable of covering all the possible values of a partial-object bit string is secured in advance as the amount or area of the pattern table. Hence, when an entry is added, this is
25 enabled simply by updating a mask pattern, and an entry

shift caused by the addition and deletion of an entry does not occur. For this reason, the overhead of table management using a higher order application can be reduced or eliminated. Therefore, it is possible to provide a bit
5 string check method and device which reduces a load on higher order application software even in packet filtering or stateful packet inspection.

Especially, in the case of the mask data, since it is possible to represent one entry by one bit, the storage
10 capacity of the pattern table is reduced to a large extent, and the pattern table loading time is reduced. Further, even in updating, the number of bits to be rewritten in the process of addition and deletion of an entry is reduced to a large extent, the processing is simplified, and the
15 processing time is also reduced. Therefore, it is effective to make the pattern table into mask data.

The process (all-check step and means) of performing comparison with all the possible values of a partial-object bit string is executable rapidly by hardware utilizing a
20 comparator or lookup table, and the scale of hardware does not also increase by dividing the process into multiple stages. Although the bit length of the partial-object bit string is not limited, the hardware becomes larger if the bit length is increased, and the number of stages of
25 checking is increased if the bit length is decreased. The

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appropriate scale of hardware changes in dependence on the purpose which the hardware will serve, the hardware's economic value, realizable wiring rules, etc. Currently, it is considered to be preferable that the bit length of the partial-object bit string is about 4 or 5 bits. In addition, it is unnecessary to change hardware algorithmically with an increase in bit length of a retrieved bit string (hereinafter, also referring to as a key) to be searched, and the above increase can be coped with by adding a unit or repeating a series of processes.

The check method and check device of the present invention have a remarkable effect in that they can be sped up by simple configuration. Firstly, the all-check step and the pattern loading step can be executed in parallel, and the overhead time, generated from the division into multiple stages, of loading the pattern table from a memory can be reduced to a large extent. Thus, it is possible to provide a check method and device which, without employing a memory of a high speed of a specific structure, exhibit a sufficiently high searching speed, are cheap and implement large capacity searching at a high speed. Such a check device exhibits high scalability and can perform memory management flexibly since the number of acceptable entries is limited only by the SDRAM capacity. Hence, a plurality of search types can be performed flexibly using a single hardware set.

bit string to be searched, and with regarding data
indicating a plurality of state transition conditions as the
plurality of registration bit patterns; and a step of
transiting states of a data processing circuit in accordance
5 with a check result of the check step.

According to the present invention, it is possible to
provide a data processing device, comprising: a check device
for checking a bit string to be searched of a current state
forming an evaluation source of a state transition against a
10 registration bit pattern indicating a plurality of state
transition conditions registered in advance; search object
provision means for providing the bit string to be searched
to the check device; and a data processing circuit whose
state is transited in accordance with an output of the check
15 device. This data processing device is a transition state
machine or an automaton processor, which can be also called
a classification processor. In this case, the check device
comprises: all-check means for comparing all possible values
of a bit string to be searched in a current stage; pattern
20 loading means for loading a pattern table of the current
state from a memory, the pattern table being for indicating
the plurality of registration bit pattern, the pattern table
being determined by check-continuation information obtained
from a preceding stage; judgment means for outputting a
25 check result indicating at least a presence or absence of

What is claimed is:

1. A bit string check method including a process of checking against a plurality of bit patterns registered in advance at multiple stages with dividing a bit string to be
5 searched into a plurality of partial-object bit strings,

wherein a current stage being one check stage included in the multiple stages, comprising:

an all-check step of selecting a partial-object bit
10 string of the current stage from the bit string to be searched and comparing the partial-object bit string of the current stage with all possible values of a partial-object bit string of the current stage;

a pattern loading step of loading a pattern table of
15 the current stage from a memory before, after or in parallel with the all-check step, the pattern table being for indicating a partial registration bit pattern of each of the plurality of registration bit patterns, the pattern table being determined by check-continuation information received
20 from a stage preceding the current stage;

a judgment step of obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with
25 the result of the all-check step and the pattern table of

string of the current stage from the bit string to be searched and for comparing the partial-object bit string of the current stage with all possible values of a partial-object bit string of the current stage;

5 pattern loading means for loading a pattern table of the current stage from a memory, the pattern table being for indicating a partial registration bit pattern of each of the plurality of registration bit patterns, the pattern table being determined by check-continuation information received
10 from a stage preceding the current stage;

 judgment means for obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with
15 the result of the all-check means and the pattern table of the current stage; and

 outputting means for outputting check-continuation information including the address of a pattern table of the stage subsequent to the current stage from an address table
20 corresponding to the pattern table of the current stage in accordance with the check result.

 22. The check device according to claim 21, wherein the pattern table is mask data consisted of a bit flag
25 indicating a validness or invalidness of the partial

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wherein the check table provided to the first check device is determined by the output of the classification device or the searching object provision means.

5 48. The data processing device according to claim 47, wherein the memory stores a check table including the pattern table and the address table, and the check table of the memory is rewritten by the data processing circuit.

10 49. A data processing device, comprising:

 a check device for checking a bit string to be searched of a current state forming an evaluation source of a state transition against a registration bit pattern indicating a plurality of state transition conditions

15 registered in advance;

 search object provision means for providing the bit string to be searched to the check device; and

 a data processing circuit whose state is transited in accordance with an output of the check device,

20 wherein the data processing device further comprises:

 all-check means for comparing all possible values of a bit string to be searched in a current stage;

 pattern loading means for loading a pattern table of the current state from a memory, the pattern table being for
25 indicating the plurality of registration bit pattern, the

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pattern table being determined by check-continuation
information obtained from a preceding stage;

judgment means for outputting a check result
indicating at least a presence or absence of the
5 registration bit pattern of the current state which matches
the bit string to be searched of the current state in
accordance with the result of the all-check means and the
pattern table of the current state of the all-check means;
and

10 outputting means for outputting check-continuation
information including the address of the pattern table of
the next state subsequent to the current state in accordance
with the check result.

15 50. The data processing device according to claim 49,
wherein the memory stores a check table including the
pattern table and the address table, and the check table
provided to the check device is determined by the searching
object provision means.

20 51. The data processing device according to claim 49,
wherein the memory stores a check table including the
pattern table and the address table, and the check table of
the memory is rewritten by the data processing circuit.